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British Columbia. 1909

MINES

HON. W. TEMPLEMAN, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
EUGENE HAANEL, PH.D., DIRECTOR.

IRON ORE DEPOSITS

OF

VANCOUVER AND TEXADA ISLANDS

BRITISH COLUMBIA

BY

EINAR LINDEMAN, M.E.



OTTAWA
GOVERNMENT PRINTING BUREAU
1910

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CANADA
DEPARTMENT OF MINES
MINES BRANCH

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EINAR LINDEMAN, M.E.

Department of Geology
University of California



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To Dr. EUGENE HAANEL,
Director of Mines,
Department of Mines,
Ottawa.

SIR,—I beg to submit herewith, the following report on the Iron Ore Deposits
of Vancouver and Texada islands, British Columbia.

I have the honour to be, sir,

Your obedient servant,

(Signed) EINAR LINDEMAN.

August 24, 1908.

IRON ORE DEPOSITS OF VANCOUVER AND TEXADA ISLANDS, BRITISH COLUMBIA.

BY

EINAR LINDEMAN, M.E.

Introduction.

With the rapid development of the west, the proposal has frequently been made to establish an iron industry on the Pacific coast, instead of importing iron products from the east. An attempt to accomplish this was made in 1880, when a small blast furnace was erected at Irondale, in the state of Washington, for the manufacture of pig iron. "It had a daily capacity of ten tons, and was a hot-blast charcoal furnace. It was operated for six months, and then was replaced by a 50 ton furnace, which, a few months later, was reconstructed, and for years turned out a good grade of pig iron, until, in 1891, it was closed down. In 1901 Pennsylvania capital was interested in it. The Pacific Steel Company was organized to acquire and operate it. The plant was modernized, and about \$100,000 expended on it, and in December, 1901, the manufacture of pig iron was resumed. Ores from Texada island, and from Hamilton, Skagit county, Washington, were used, mixed in the proportion of 700 tons of Texada ore to 50 tons of Hamilton ore. The Texada ore was arranged in large heaps, and roasted to get rid of the sulphur, and also to render it porous, to facilitate reduction. The principal flux was limestone, and the chief fuel was charcoal, with a little coke from Cokedale, in Skagit county. Castings were made three time a day. The pig iron was sold to the various foundries around Puget sound, Oregon and British Columbia."¹

As the attempt did not meet with success, the plant was soon shut down. This fact has not had a deterring effect; on the contrary, new efforts have, during the past year, been made to re-open the works, and the possibility of this American iron industry resuming has stimulated prospecting for iron ore on the coast of British Columbia.

In the summer of 1907 the writer spent the field season in studying the reported iron ore deposits of Vancouver and Texada islands. It is the purpose of this report to give the result of that work, but, in doing so, the writer desires to state that, with very few exceptions, none of the iron ore locations have had any more development work done than was necessary to meet assessment requirements. A few strippings, or an open-cut, is often all that can be seen.

¹ See general review of mining in British Columbia, Bulletin 19; Victoria, B.C.

Character of the Ore Deposits.

Magnetite is the most common iron ore on the coast of British Columbia, and numerous outcrops of this mineral are found both on the west and east sides of Vancouver island. They are usually found on the end or flank of a ridge, following roughly the contours of the hill, and occur almost always along and adjacent to the contact of limestone and some eruptive rocks. Numerous fragments of the ore have frequently fallen down the slopes, giving an impression that the ore occupies a larger area than it actually does. The contact of the ore and the country rocks is, as a rule, well defined, but the shape and extent of the ore is very uncertain because of its extremely irregular association with the wall-rocks, and in many cases it is not safe to assume that the ore extends a foot beyond, or a few inches below the place of observation. The highly magnetic character of this magnetite can, however, in many cases be taken as a good guide. A strong, and even magnetic attraction for some distance on a claim, shows the presence of a larger ore-body, and should encourage further development to ascertain the real extent of the ore and its quality. On the other hand, walking over an outcrop of magnetite, and finding none, or very small magnetic attraction, is an indication that the conditions are not very encouraging for further work.

On Vancouver island numerous claims have been staked where the last-mentioned conditions exist, and where the few available workings show the ore to occur in stringers, blankets, and pockets. That the prospect is not very encouraging is apparent, and many property holders, instead of lulling themselves into the belief that the ore will widen out with depth, should watch the behaviour of a little dip needle over their outcrops of magnetite. By doing so they would save themselves from unnecessary hard work and expenditure of money.

There are, however, a few properties, the surface indications on which are so promising that they must, sooner or later, become objects for exploration and development, when conditions are such that profit may be derived from iron mining on the coast. Amongst these are the iron mines on Texada island, and the properties at Head bay, Klaanch river, Quinsam river, and Gordon river on Vancouver island.

The magnetites of the coast are high in iron, some masses containing over 70 per cent of iron, although the ores, as a whole, will probably not average over 55 to 60 per cent. The phosphorus content is very low, most of the samples taken showing a percentage considerably below the Bessemer limit. The sulphur content is, on the other hand, high, and local abundance of sulphides is very common. A thorough roasting of the ore might, therefore, be necessary. Until the ore deposits are further developed, any discussion of their origin must be tentative, and perhaps ought not to be attempted. Yet certain features in regard to their manner of occurrence are so significant that a few words may be of interest. The fact that nearly all magnetic exposures, if not in contact with crystalline limestone, are at least in the immediate vicinity of it, and occur where it is in close proximity to some igneous rocks, seems to indicate that the effects produced by the intrusion of these eruptive rocks into the limestone have given origin to these deposits. The suggestion is made, that the ore is a replacement of limestone, through the agency of iron solutions and vapours following the eruptive magmas.

Hematite.—Admiral island was the only place visited by the writer which showed hematite. Grey and green schists, associated with jasper, carrying some small bands of hematite, which in places seemed to change into magnetite, were, however, all that could be seen.

Limonite, or bog iron ore, has been found in several points at the north end of Vancouver island. For further description see page 17.

DESCRIPTION OF DISTRICTS.

Sooke District.

At a distance of about twenty miles from Victoria, on the southwest end of Vancouver island, Sooke harbour is situated. The east Sooke peninsula, with Mount Maguin, lies to the south of this harbour.

The country rocks here are mainly made up of igneous and metamorphic rocks, carrying in places chalcopyrite, magnetite, and pyrrhotite. In 1900 the Pacific Steel Company took a bond on several claims on lots 79 and 83, and did some development work, consisting chiefly of stripping, and open-cuts, at various points on the slope of a hill. The ore has, however, a very irregular shape, and shows no sign whatever of permanency. The workings expose, as a rule, a dark-green metamorphic rock, containing much hornblende, and patches of magnetite and pyrites. The claims seem, therefore, not to be of any practical value for an iron industry.

East of these claims, on lot 3, a short distance back from the beach, and about 100 feet above sea level, an outcrop of pyrrhotite and magnetite was observed. A shaft has been sunk on the outcrop, and a tunnel driven into the hill, but it did not go through the surface soil. On the dump there was a pile of magnetite, containing a notable percentage of pyrrhotite and some copper pyrites.

Gordon River District.

The Gordon river flows from the north into Port Renfrew, or Port San Juan as it is locally known, which is about sixty miles from Victoria, on the west coast of Vancouver island. Up this river, and its principal tributaries, the country rocks are chiefly crystalline limestones, and igneous rocks, of which granites and diorites are most in evidence.

Rose claim is situated on the north bank of the Gordon river, about five miles from salt water, and is connected therewith by a good trail. On a small outcrop of magnetite considerable development work has been done, mainly consisting of sinking a shaft, and drifting from it at different levels. The shaft was full of water at the time of my visit, but Mr. Carmichael, Provincial Assayer of British Columbia, who visited the place during the summer of 1902, gives the following report on the claim: "Close to the camp, a shaft had been sunk about 300 feet, on a magnetite outcrop, which appeared to dip into the hill. At about 100 feet down this shaft, a cross cut drift of 40 feet had been run to the north. This drift was

not examined. It was reported by the foreman to be boarded up, and all work had been suspended for the time at this point, but it was stated by the management that the drift had been run for about 40 feet, and had cut diagonally through about 18 feet of ore mixed with country rock. Similar drifts had been set off at the 200 and 300 foot levels simultaneously, that at the 200 foot level being now in about 18 feet, and that at the 300 foot not so far. In neither of these drifts, nor in the shaft, was any ore visible, the rock passed through being chiefly diorite, though, of course, these drifts had not been driven far enough to strike the ore-body, should it continue to this depth, at the surface dip. The equipment consists of one drill, Rand air compressor, and a small power hoist, both operated by steam."

Following up the Gordon river for about three-quarters of a mile, several strippings and trenches, some of them showing magnetite, were noticed on both banks. The development work done has not, so far, proved the ore to be of any extent; on the contrary, the workings show a number of small discontinuous bodies situated roughly along the contact line of the limestone and the igneous rocks.

The Baden-Powell and Little Bobs mineral claims are situated farther up the Gordon valley, about seven miles from salt water. An outcrop of magnetite is found on the flank of a ridge, along which it can be traced for 350 feet. In several places on the ridge a sharp contact between the ore and an igneous rock was observed. About 90 feet below this contact a tunnel 114 feet long had been run directly into the hill, showing magnetite in its full length; with the exception of a diorite dike 8 feet wide, about 30 feet from the mouth.

An average sample of the ore taken along the tunnel gave the following analysis:—¹

	Per cent.
Insoluble matter.	8.88
Iron.	58.30
Sulphur.	2.75
Phosphorus.	0.013

About 35 or 40 feet below this tunnel, another tunnel had been run in the same direction for 114 feet into the hill, going through limestone and diorite. The last few feet, however, show magnetite, dipping in towards the hill.

East of this main outcrop, and close to the trail leading down to the main trail up the Gordon valley, several strippings had exposed magnetites, but did not give sufficient information in regard to the extent of the ore-bodies.

The *Sirdar* mineral claim is situated two miles farther up the valley, and is very similar to the *Baden-Powell* and *Little Bobs*. The magnetite outcrops here along the face and brow of a ridge for about 160 feet.

About 50 feet below the top of the ridge a tunnel had been run 103 feet into

¹ All analyses given in this report have been made by Mr. H. Leverin, chemist to the Mines Branch.

the hill, showing the width of the ore to be about 82 feet. An average sample taken along the tunnel gave the following analysis:—

	Per cent.
Insoluble matter.	8.52
Iron.	56.57
Sulphur.	2.75
Phosphorus.	0.121

West of the Sirdar, a large number of iron claims have been located, adjoining each other for a distance of about $1\frac{1}{2}$ miles along the slope of the Gordon valley. They do not all show, however, magnetite in place, and only the claims on which any development work had been done were examined. The principal workings are on the *Conqueror* claim, situated on Bugaboo creek, a tributary to the Gordon river. The claim is some nine miles from the navigable water of Port San Juan. A solid body of magnetite about 40 feet high is exposed in the canyon of the creek, over which the creek forms a water fall. The ore has a maximum width of about 63 feet on the east side of the creek, but becomes narrower on the west side. On the east side the ore body is stripped for about 80 feet from the creek to where it runs into the gravel bank. At the foot of the bluff, a tunnel, 14 feet long, had been run into the ore, showing solid magnetite. A sample taken along the tunnel gave the following analysis:—

	Per cent.
Insoluble matter.	4.51
Iron.	67.09
Sulphur.	1.60
Phosphorus.	0.009

On the up-stream side the ore body is confined by a diorite dike 6 feet wide, crossing the creek nearly at right angles. Beyond this dike, outcrops of magnetite were noticed on both banks of the creek for a distance of about 60 feet, and on the east side for 15 feet farther. Here, in several places, the ore seems to lie as a blanket on top of a green igneous rock. At about 200 feet east of the creek some outcrops of magnetite were reported to have been struck by stripping, but the workings had caved in at the time of my visit. Between these strippings and the creek a strong magnetic attraction was noticed in several places. From the existing development it was impossible, by a superficial examination, to get any information as to the extent of the ore body, or bodies, as the solid formation is effectively covered by a sandy loam. A magnetometric survey would, undoubtedly, give a large amount of information here.

The same may be said about *David* mineral claim, east of the *Conqueror*, and adjoining the Sirdar on the west side. Within a distance of 400 feet along a slope some strippings have exposed a good magnetite in several places, but do not give sufficient information to warrant an estimate of the ore. On some other claims several outcrops of magnetite of little interest were noted.

The great supply of good timber, in which the Gordon river valley is so rich, will, undoubtedly, assist some future mining industry in building a railway from the claims to the navigable water of Port San Juan.

Copper Island.

Tzartos, or Copper island, as it is better known locally, is the largest of a chain of islands running northeast and southwest in Barkley sound, and separating the eastern channel from the west. Several iron claims have been staked here, and can best be reached from Clifton point, near the middle of the east coast of the island. Open-cuts are found at intervals over a great area, but the most important development work has been done on the Mountain claim, situated a short distance inland from Clifton point, and about 700 feet above sea level. Here, on the hillside, an outcrop of magnetite, very irregular in shape, has been exposed by considerable stripping and quarrying. The principal quarry has been exposed for about 75 feet, with a face about 35 feet high. The quarry, which first goes through a good solid magnetite for about 15 feet, cuts through a small granite dike, and enters then for some 45 feet an igneous rock, mixed with magnetite and forming a species of ore-breccia. Farther in, the rock is practically free from magnetite, although a continuation of the ore may be seen on the surface for some distance farther up the hill side. The 12 ft. shaft, which had been sunk at the entrance to the quarry in good solid magnetite, was filled with water at my visit, but it is reported to have struck country rock at the bottom. A few feet south of the main quarry a little open-cut in the hill shows a blanket of magnetite apparently resting on the country rock and following the slope of the hill. About 60 feet south of the main quarry, another cut has been made, which shows some ore with very irregular shape, partly resting on a granitic rock and partly penetrated by dikes of the same kind. The cut had been run for 45 feet and from this point had been continued as a tunnel. At about 27 feet from the mouth of the tunnel drifts had been run at right angles, that to the left having been driven 6 feet, and that to the right 20 feet, while the tunnel had been continued for an additional 76 feet. No magnetite could be seen in the tunnel, other than a small showing near the entrance and in the drift to the left. The tunnel goes below the surface exposure, on which the two first-mentioned cuts had been driven, and shows also that the ore does not go down here. The ore taken from the various workings had been piled up, and an average sample of the pile gave the following analysis:—

	Per cent.
Insoluble matter	16.52
Iron	52.09
Phosphorus	0.025
Sulphur	0.230

From these workings to the top of the mountain, magnetite is found as irregular impregnations and stringers in the country rocks, practically over the entire slope, and several strippings and open-cuts have been made, but none showing any evidence to warrant further development.

Sarita River.

The Sarita river flows into the eastern channel of Barkley sound, twelve miles from Cape Beale, and directly opposite Copper island. It forms at the mouth a

great delta, and the valley is bordered by low hills on either side. About a mile up the river, and about a quarter of a mile back from the south bank, a bluff of good magnetite outcrops on a ridge running east and west parallel with the river. The height of the ore bluff is about 60 feet; the width could not be obtained, but the ore incloses in several places a greenish metamorphic rock, and crystalline limestone, which seem to form the foot-wall. A tunnel has been driven at the base of the ore bluff, following the strike of the ore and showing the length of the ore-body to about 120 feet. In the tunnel on the left side and about 30 feet from the mouth, a winze had been sunk 10 feet, striking barren rock in the bottom. The ore taken from the tunnel had been piled up, and an average sample of the ore pile gave the following analysis:—

	Per cent.
Insoluble matter.	3.81
Iron.	60.89
Sulphur.	0.76
Phosphorus.	0.004

Following the crest of the hill back in an easterly direction, several strippings and open-cuts were noticed, showing in the majority of cases some magnetite, but the magnetic attraction around and between them is, as a rule, very weak; often there is none, which indicates that the ore is not continuous, but that it occurs more in the form of pockets. Some of the workings tend to confirm this supposition, since they give little evidence of stability, or extensiveness of the ore. At a distance of about 1,000 feet from the bluff, a shaft had been sunk on an outcrop of magnetite. The outcrop is 52 feet long, and about 25 feet wide, and shows a good clean magnetite. The shaft, 21 feet deep, was filled with water, but it is reported to have struck country rock after the first 10 feet in ore.

Alberni Canal.

Alberni canal is an extension of Barkley sound. Not far from its entrance is Uchucklesit harbour—situated to the north. Some iron claims were reported in this vicinity, and were, therefore visited.

Iron Mountain mineral claim is situated on the west shore of Anderson lake, which empties through a short river into Uchucklesit bay. The distance from the mouth of the river up the bay to the claims is about nine miles. Here a small creek flows into the lake, and a couple of hundred feet up the valley, at an elevation of about 160 feet above the lake, some surface stripping had been done on the east bank of the creek, showing patches and bands of magnetite in a basic rock, having a very weak magnetic attraction. Farther up the hill other workings were noticed, but none giving any evidence of containing magnetite in commercial quantity. A dark-green hornblendic rock, impregnated in places with a little magnetic, and sulphides of copper and iron, was all that could be seen.

Defiance mineral claim is situated on the north shore of Alberni canal, about one mile east of Uchucklesit bay, and about one mile from salt water, at an elevation of about 850 feet above sea level. Surface stripping had partly uncovered two lenses of magnetite, each exposure showing a length of about 65 feet.

In one place one of the ore-bodies had been cut by a creek, exposing the ore to a depth of about 12 feet. From a width of about 6 to 7 feet, which the ore has at the upper part of this cut, it pinches to about 2.5 feet at the bottom. An average sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter.	4.37
Iron.	66.89
Phosphorus.	0.024
Sulphur.	0.060

East of these main outcrops several others were noted, with very irregular shape, and carrying in places some copper pyrites. One had been stripped for about 30 feet, with a width of 17 feet. By a creek cutting through it at the north end, it was shown to be a blanket, 3 feet thick, resting on limestone, although at the contact of the limestone and the igneous rock it went down somewhat deeper, with indications of pinching out.

Darby and Joan mineral claims.—Smiths Landing is situated about six miles farther up the canal, on the east side. From here a good trail, about a quarter of a mile long, leads to Darby and Joan mineral claims. Some surface strippings, and a few open-cuts have exposed a magnetite, which, running approximately north and south along the hill, can be traced about 115 feet. The width of the ore is about 11 feet, but decreases towards the north end, where it is only 6 feet. North of the main outcrop, several open-cuts and tunnels had been run into the hill, but only showed barren country rock, which is a dark to light-green diorite. No magnetic attraction could be noticed north of the ore outcrop, but the attraction was strong south of it, for a distance of about 70 feet. An average sample of the ore dump gave the following analysis:—

	Per cent.
Insoluble matter.	25.95
Iron.	50.96
Phosphorus.	0.004
Sulphur.	0.083

Sechart.

On the peninsula lying between Pipestem inlet and the middle channel of Barkley sound, Broughton range is situated. The strike of the range is about east and west, and along its slope a number of mineral claims have been located, adjoining each other.

Western Steel is situated farthest west. In a distance of about 270 feet several outcrops, strippings, and a little shaft, showed a good clean magnetite.

An average sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter.	12.76
Iron.	59.69
Phosphorus.	0.016
Sulphur.	0.040

As the formation was chiefly covered by sandy loam, a magnetometric survey was made to obtain some information regarding the extent of the ore. The accompanying map (No. 49) of the vertical magnetic intensity, indicates that the occurrence is very irregular.

Bald Eagle claim lies to the east of Western Steel. The hillside had been stripped, showing an exposure of magnetite about 70 feet long, with a width of about 30 feet up the slope. Thirty feet below this outcrop, a drift had been run directly into the hill underneath the surface exposure. No ore was visible in the drift, which showed a light-coloured, igneous rock, on which the magnetite exposure of the slope apparently rests as a blanket. Farther up the hill the contact between this igneous rock and crystalline limestone was noted, and also a small exposure of magnetite, but not of sufficient size to be of any interest.

An average sample of the exposure above the drift gave the following analysis:—

	Per cent.
Insoluble matter.	13.36
Iron.	59.37
Phosphorus.	0.006
Sulphur.	0.716

Crown Prince is situated on the north side of the Broughton range, on its slope towards Effingham inlet, about two and a half miles from Sechart. The land rises very rapidly from Effingham inlet, and on a bluff about 75 feet high some cross-cutting and stripping had been done, exposing some magnetite of irregular shape, in a green metamorphic rock. At the base of the bluff a tunnel had been driven into the hill underneath the outcrop of magnetite exposed on the bluff. The tunnel went through the decomposed rock and some lime for a distance of about 55 feet, and then the rock became mixed with magnetite and iron pyrites, until solid magnetite was struck, 70 feet from the mouth of the tunnel. From this place to the face, a distance of about 16 feet, the tunnel is in solid magnetite, the face still consisting of ore.

About 42 feet from the mouth a drift had been run for 67 feet to the left, making an angle of about 32° with the main tunnel. The drift was in a dark-green hornblendic rock, mixed with some magnetite and pyrites. The last 14 feet on the right hand side showed, however, a fairly clean magnetite.

An average sample of the ore dump gave the following analysis:—

	Per cent.
Insoluble matter.	23.22
Iron.	48.06
Phosphorus.	0.006
Sulphur.	0.623

The surface on the top of the bluff had been cleared by surface stripping in several places, which exposed some outcrops of magnetite. Following the ridge in a westerly direction, strong magnetic attraction was also noted. North of the bluff, several trenches had been made into the steep slope of the hill, showing in places good magnetite. Though the development done thus far has proved little

of the real value of the claim, the prospects may be said to be such as to warrant further investigation.

Kennedy Lake.

Kennedy lake is the largest lake on Vancouver island, and empties through Kennedy river into Tofino inlet. Elk river flows into the lake from the northeast. About one and a half or two miles from the lake shore, on the left side from the mouth of the river, some mineral claims have been staked. In a deep and steep ravine several outcrops of magnetite were noted on the contact of crystalline limestone and granite. No development work, however, had been done to show the extent of the magnetite, and as the slopes in many places were too steep to climb, no reliable measure of the outcrops could be obtained. Numerous boulders of magnetite were noticed further down the valley, some of them reaching a considerable size. To judge from the development done, chiefly consisting of two tunnels driven on a quartz vein, the claim seems to have been staked more on account of its showing of free milling quartz than for its iron ore.

A sample of the magnetite gave the following analysis:—

	Per cent.
Insoluble matter.	7.64
Iron.	63.07
Phosphorus.	0.016
Sulphur.	0.043

Maggie Lake.

In a bay of Kennedy lake—to the southeast, somewhat east of Rocky island, and about two miles east from its inner end, is situated Magnetic creek, running in a southerly direction, and flowing into Maggie lake. A strong magnetic attraction was reported on the west bank of this creek, about four miles from its outlet in Maggie lake, and was verified by the writer. At the point referred to, about 300 feet back from the creek, strong magnetic attraction was noted for a distance of about 300 feet. The ground is, however, composed of a sandy loam, completely covering up the rock formation, and no indication of magnetite was observed, except magnetic attraction. Some pits had been sunk, and a tunnel driven into the bank, but nothing but sandy loam had been disclosed, either in the pits or in the tunnel.

Head Bay.

Head bay forms the upper end of Tlupana arm, Nootka sound. On a ridge running northwest and southeast, four outcrops of magnetite can be seen at intervals, along a contact of crystalline limestone and diorite, about a mile from deep water in the bay. These outcrops are from 170 to 200 feet long, and have a maximum width of 40 to 55 feet. A little farther south, several smaller outcrops were noted, showing that there is undoubtedly strong mineralization by iron here. Up to the present time, however, no work has been done to show the extent of the ore, with the exception of one place where some stripping had been done, and an open-cut made at right angles to the strike of the ore into the hill, exposing the ore for

about 55 feet. The ore is of good character, and an average sample, taken along the cut, shows:—

	Per cent.
SiO ₂	6.10
FeO.....	28.61
FeO ₃	62.24
Al ₂ O ₃	0.35
Ca ₂ O ₃	1.15
MgO.....	0.44
Cu.....	trace.
S.....	0.017
P.....	0.016

It is impossible from development done to get any reliable estimate of the ore quantity, but it may be pointed out that the surface showings are so promising that they ought to encourage further development of the property.

West Arm, Quatsino Sound.

The country north of the West Arm of Quatsino sound has, during late years, attracted much attention, owing to the discoveries, at several points, of limonite in the form of bog ore. The country rocks are chiefly eruptive rocks, as granites and felsitic rocks, the latter often heavily charged with iron pyrites. The origin of this bog-ore can best be described by quoting from Kemp's "Ore Deposits," pages 87 and 89:—

"Bog-ore, beds of limonite, superficially formed in marshes, swamps and pools of standing water. The general circulation of water through the rocks enables it very frequently to take up iron in solution. Ferruginous minerals are amongst the first and easiest that fall a prey to alteration. Carbonic acid in the water aids in dissolving the iron, which thus, in waters containing an excess of CO₂, passes into solution as the protocarbonate Fe CO₃. Organic acids may also play a part. The alteration of pyrite affords sulphuric acid and ferrous sulphate, and the latter enters readily into solution. On meeting calcium carbonate, both ferric and ferrous sulphate are decomposed, yielding in the first case calcium sulphate, ferric hydrate and carbonic acid; in the second place, if air is absent, ferrous carbonate and calcium sulphate, but on the admission of air, ferric hydrate soon forms."

This ferric hydrate, i.e. limonite, is formed as a red scum, and then sinks to the bottom, where, beginning as a light film, it gradually accumulates. On all the hills where this iron pyrites occurs, this rusty impregnated water can be observed during the wet season, percolating down the hillside. Hence, on the divide between Iron creek and Nahwitti river, and down these water-courses for some distance, a great number of mineral claims were staked last year. No development work has so far been done, however, since with the exception of rusty water running down the hillsides, and some very light films of limonite in the creeks and swamps, no indication of bog-ore could be seen.

The claims which at present give the best showing of bog-ore are situated about one mile west of Coal harbour. They lie in and on the border of swampy basins, and partly on the ranges of the adjoining hills. The ore has been exposed by some strippings and open-cuts, and a number of outcrops are also visible in the banks of some small creeks. On the hillsides where the accumulation of the limonite has gone on without intervening disturbances, the ore is generally clean and free from other admixture. In the dry season the limonite becomes hard, forming a solid crust, which, during the succeeding wet season, will be buried under more ore solution. The thickness of the ore thus accumulated varies considerably, depending on the supply of ore solution and the topography of the ground. If in a depression in the ground the ore may be quite thick, while, on the other hand, with a little elevation of the ground only a few feet from the latter place, none, or only a few inches of ore may exist. Thicknesses from a few inches to 6 feet were noted, but it was reported that in one place a thickness of 18 feet had been obtained by drilling. The greatest depth has been found in the vicinity of two creeks on the Eagle and Sunrise claims, and although the ore in many places is clean, some of the outcrops show a serious mixture of fractions of the country rocks embedded in it. These have been transported here during the wet season, by the high waters from the hills above. The limonite has then been precipitated between them, and the whole now forms a kind of ore breccia. In the swamps, on the other hand, the ore is associated with peat, in layers of varying sizes.

Two average samples taken from two different open-cuts, where the ore was clean, gave the following analysis:—

	I.	II.
	Per cent.	Per cent.
Insoluble matter.....	2.32	1.40
Iron.. .. .	54.46	56.97
Sulphur.. .. .	0.15	0.447
Phosphorus.....	0.038	0.038

Although the development done certainly shows that some good ore may be obtained from these properties, it has not so far proved the ore to be of sufficient quantity to warrant exploitation. The country being for the greater part covered with soil and sandy loam, which in some places is quite deep, it was impossible to get any exact idea about the extent of the ore. The general irregularity of such an ore, both in regard to the depth and extent—which is a natural consequence of its formation; the fact that the ore in many places is mixed with peat and in others with float of the country rocks—which reduces its value, and, if present in greater quantity, make it unfit for iron making, if not removed by separation, are all factors that should urge to great caution. A systematic drilling and careful sampling of these drillings is the only way to ascertain whether the ore, no matter how promising it may look in places, really has extent, thickness, and quality enough to warrant the cost of mining, and the necessary expenditure for transportation facilities..

Klaanch River.

Nimpkish lake is fifteen miles in length, with an average width of rather less than a mile. It empties at the north end through Nimpkish river into Broughton strait, at a point directly opposite Alert bay. At the south end Klaanch river flows into the lake from the southeast. About seven miles up this river, on the south side of it, several claims have been staked, showing some magnetite. The claim of the most interest is, however, *Iron Crown* mineral claim. An exposure of magnetite extends along the face of the river bank for some 180 feet. The height of the bank is about 80 or 100 feet, forming at some points, cliffs of magnetite 25 to 30 feet high. A sample of the ore gave the following analysis:—

	Per cent.
Insoluble matter.	4.12
Iron.	64.23
Sulphur.	0.233
Phosphorus.	0.010

Farther up the hill, about 650 feet from the river, several outcrops of magnetite occur along the ridge. An average sample from these gave the following analysis:—

	Per cent.
SiO ₂	5.30
FeO.	26.70
Fe ₂ O ₃	61.56
Al ₂ O ₃	1.74
CaO.	0.80
MgO.	1.86
Cu.	trace.
S.	0.017
P ₂ O ₅	0.037

The solid formation being effectively covered by a sandy loam and a heavy vegetation, the outcrops mentioned were all that could be seen, but as the dip-needle showed a very strong magnetic attraction in several places, it was found advisable to make a magnetic survey to get some information in regard to the extent of the ore bodies. The topography of the ground, the heavy vegetation, and the great number of wind-falls delayed this investigation very much.

In the magnetometer the vertical force of the normal terrestrial field is counterbalanced beforehand by a small weight on the arm of the needle. Through the swinging of the needle in a plane, as above mentioned, the horizontal intensity of the earth's normal magnetic field and the horizontal component of the magnetic force of the ore body become annulled, and the vertical component of the magnetic force of the ore body is, therefore, the only magnetic force which affects the needle, and according to its strength in the different places, causes the different readings marked on the map. The places which have positive magnetic intensity, i.e. when the north pole of the magnetic needle points below the horizontal plane, are marked blue, and, on the other hand, the places with negative magnetic intensity, i.e.

where the south pole of the needle points below the horizontal plane, are marked yellow on the map.

To avoid misunderstanding by any person who is not familiar with magnetic maps of this kind, I desire to point out that all the area coloured blue cannot be considered to be underlaid by magnetite, but only a certain part of it. Further development work will find the magnetite underneath the places with the highest positive readings, and north of them for a short distance down the hill, and here outcrops of magnetite were, and will be found where strong negative readings were observed. This fact is due to the topography of the ground, the instrument being set up below the upper pole of the ore body. This attracts the north pole of the magnetic needle and causes the negative reading.

The map shows three separate deposits or groups of deposits, which for reference have been numbered I, II, and III.

No. I outcrops on the river bank, as before stated. The top of the bank is covered with soil, and no work has been done to ascertain the width of the deposit; but to judge from the magnetic curves, and outcrops available, the width at the west end may be estimated at not less than 100 feet. The length of the ore body may be assumed to be about 190 feet.

Group II is the most important, and may be assumed to consist of two, possibly three, ore lenses, not counting the small pockets in the southern part of the group. The largest of these ore lenses has a length of at least 380 feet; a width of 60 feet is very probable, and in some places it is even greater.

Group III is altogether covered by soil. The magnetic curves show, however, the ore strikes to be about parallel with the former group, with a length of about 480 feet, and a width which, in places, may be assumed to be very little less than that of the former.

In regard to the depth of the different ore lenses, no conclusion can be drawn from the magnetic map; but as far as surface indications go, the claim may be said to be one of the best iron prospects on Vancouver island, and well worth further development.

Quinsam River.

The Quinsam is a tributary of the Campbell river, which flows into the strait of Georgia at a point about 35 miles north of Comox, and directly opposite the south end of Valdes island. The mineral claims are situated on a tributary of the Quinsam, about 13 miles from the coast.

Magnetite outcrops here on the north bank of the river, in a bluff about 80 feet high. Part of the face of this bluff has been stripped for 53 feet in width, showing solid magnetite, without having uncovered the contacts with the country rock. About 40 feet above the river a tunnel had been driven into the hill, following the strike of the ore. The tunnel was 60 feet long, entirely in magnetite.

A sample taken along the tunnel gave the following analysis:—

	Per cent.	
SiO ₂ ..	7.00	
FeO..	22.82	} Iron. 56.45
Fe ₂ O ₃ ..	56.71	
Al ₂ O ₃ ..	2.07	
CaO..	3.77	
MgO..	1.25	
P ₂ O ₅ ..	0.03	
S..	0.53	
Cu..	0.70	

Another sample taken across the face of the bluff above the tunnel gave the following analysis:—

	Per cent.
Insoluble matter..	11.00
Iron..	59.77
Sulphur..	0.533
Phosphorus..	0.024

Following the crest in a north-northwest direction, some outcrops and surface strippings were noted. These indications, and strong magnetic attraction, show the ore to be continuous for a distance of about 350 feet. The ore is generally free from admixture with country rock, though containing some sulphides of copper and iron. On the south side of the river, some small outcrops of magnetite may be seen along the slope. A few hundred feet farther up the valley a seam of coal outcrops on the north bank of the river.

Texada Island.

The iron ore deposits which occur on the western slope of Texada island, from three to four miles north of Gillies bay, have been known for many years, and were taken up for iron mining as early as 1875. The principal ore deposits are on the Prescott, Paxton and Lake properties.

The *Prescott* mine has been the most largely developed, and has during several years shipped ore to Irondale, Washington. The magnetite outcrops about 850 feet from the shore, in a big bluff on the brow of a steep rocky hill, at the contact between granite and crystalline limestone. The deposit has been opened at three levels. At an elevation of 365 feet an open-cut had been made into the hill, showing magnetite, penetrated by granitic dikes. Sulphides of copper and iron are also common here. The second level is situated 40 feet above. A considerable amount of ore has been taken out from an open-cut, which shows a face of magnetite 40 feet wide and about 100 feet high.

The ore includes small patches of calcite, and fragments of volcanic rocks, forming in places a species of ore breccia. More or less sulphides of copper and

iron are also present. An average sample of the ore dumps gave the following analysis:—

	Per cent.
Insoluble matter.	6.46
Iron.	62.57
Sulphur.	0.403
Phosphorus.	0.024

The third level is situated 60 feet above the second, at an elevation of 465 feet above sea level. The cut has been made following the strike of the ore body, and the face of it is about 50 feet high and 50 feet wide, showing the same kind of ore as at the second level. With some hand sorting, the ore will give a good merchantable magnetite. An average sample of the ore dumps gave:—

	Per cent.
Insoluble matter.	12.00
Iron.	58.76
Sulphur.	0.113
Phosphorus.	0.011

It is very difficult to determine the extent of the ore body. Between the second and the third level the ore was traced along the hill for about 200 feet, with a width on the third level of about 80 feet. These figures must, however, be regarded as only approximate.

About 430 feet below the top of the bluff, and at about 130 feet above sea level, a tunnel had been run into the hill, under the quarry. The length of the tunnel is 630 feet, going through granite and felsitic rocks, and showing solid magnetite for the last 75 feet on the west side of the tunnel, and for 45 feet on the east side. The tunnel has demonstrated that the depth of the ore is at least 430 feet, and that the quality of the ore is not inferior to that of the upper levels.

An average sample of the ore taken along the tunnel gave the following analysis:—

	Per cent.	
SiO ₂	4.37	
FeO.	28.09	} Iron 63.27
Fe ₂ O ₃	60.60	
Al ₂ O ₃	1.18	
CaO.	2.58	
MgO.	1.05	
Cu.	0.09	
S.	0.347	
P ₂ O ₅	0.013	

From the Prescott mine the contact between the limestone and the eruptive rocks, though in many cases covered by a sandy loam, can be traced for about 1,200 feet farther up the hill, and after making a sharp bend down hill again for about 800 feet, it takes a more easterly direction, making some windings, to the Paxton mine, and then to the Lake mine. Strong magnetic attraction in some places, and

numerous outcrops of magnetite, were noted along this contact, some of the outcrops reaching a width of about 70 feet. It was not possible to get any idea in regard to the real extent of these ore bodies, as hardly any development work had been done, but the character of the contact deposits, on the borders of the granite, indicates the importance of closely examining the contact of the eruptive rocks with the limestone. On account of the lateness of the season, a magnetometric survey could not be made.

The *Paxton* mine is situated about 3,500 feet east of the Prescott mine. Some outcrops of magnetite extend along the face of a ridge for some 500 feet. This deposit has been exploited by two open-cuts passing through granite, which seems to form the hanging wall, and then into the ore. None of the cuts have been driven entirely through the ore body, so that it is not possible to determine its full width. From the face of the east open-cut a tunnel 45 feet long has been driven in the same direction as the cut, and showed solid magnetite, carrying some sulphides of copper and iron.

An average sample taken along the tunnel gave the following analysis:—

	Per cent.
SiO ₂	4.47
Fe	64.48
Al ₂ O ₃	0.66
CaO	1.32
MgO	1.13
Cu	0.22
S	1.866
P ₂ O ₅	0.005

The *Lake* mine is situated about 1,300 feet to the east of the Paxton. The ore can be traced along the face and brow of a ridge for some 200 feet. The height of the ore bluff is about 80 feet, with a maximum width on the surface of about 100 feet. An open-cut had been made in the ore body, showing a good clean magnetite. About 1,000 tons of ore were reported as having been shipped last summer to Irondale, Washington.

An average sample of the ore gave the following analysis:—

	Per cent.
SiO ₂	8.33
FeO	25.07
Fe ₂ O ₃	57.96
Al ₂ O ₃	1.71
CaO	3.82
MgO	1.05
Cu	0.08
S	0.137
P ₂ O ₅	0.057

Though it is impossible to make even an approximate estimate of the ore in sight on these properties in Texada island, because sufficient development has not

been done to warrant such an estimate, there is every probability of large quantities of merchantable magnetite being found. The properties are situated close to the water front, and a little bay offers good facilities for shipping. From none of the claims has the ore to be transported more than a mile and a half, and in some cases considerably less.

POSSIBILITIES OF AN IRON INDUSTRY ON THE COAST OF BRITISH COLUMBIA.

The growing demand in British Columbia for manufactured iron in all its forms, and the high price of these supplies at the present time—due to the heavy freight charges from eastern points, or from Great Britain—has, during the last few years, often raised the question, whether it was possible to manufacture the needed iron in that province. A few facts in regard to this matter may, therefore, be of interest.

Ore Supply.

From what has been said in this report it is evident that it is impossible, from present development, to give actual figures as to the ore in sight. Making due allowances for lack of development, and possible shallowness and change of character with depth, the better properties on the coast should be capable of supplying a tonnage sufficient for a local iron industry. A well-equipped and properly managed plant, using these magnetites thoroughly roasted, could also produce a good quality of pig iron.

Fuel.

In regard to fuel, the east coast of Vancouver island has a good supply of coal. The output from the collieries is estimated, for the year 1907, at 1,325,000 tons of coal. During the same year about 17,000 tons of coke were made. The Provincial Mineralogist of British Columbia reports the coke to contain from 15 to 16 per cent ash, but thinks that, by a more careful separation of shale from the coal, the ash could be reduced to about 12 per cent with very low phosphorus contents.

Fluxes.

The limestones abundantly met with on the coast are exceptionally pure, and free from deleterious elements, and offer, therefore, a good flux. The supply may be said to be practically unlimited. Two samples of limestone, one taken on Texada island, the other at Head bay, Vancouver island, gave the following analyses:—

	Head bay. Per cent.	Texada. Per cent.
Insoluble matter.	1.0	1.17
Iron oxide and alumina.	0.5	0.78
Calcium carbonate.	97.0	96.54
Magnesium.	0.7	1.47

Transportation.

Cheap transportation of the raw materials is one of the most important factors in a successful iron industry. The many inlets which indent the coast and the islands of British Columbia, offer great advantages for transportation, as the iron ores, limestones, and coal deposits are situated close to, or within easy reach of these navigable waters. Navigation being open the year round is another advantage to the blast furnaceman, and the miners, saving them a large expenditure in stocking and rehandling the raw materials.

Cost of Making Pig Iron; also Market Conditions.

On account of the great percentage of ash in the coke—say 15 per cent—the amount of coke required to melt a ton of pig iron may be estimated at $1\frac{1}{4}$ tons. With coke at \$6 per ton the cost of fuel would, therefore, amount to about \$7.50 per ton of pig iron.

To be on the safe side, let us estimate the iron content of the magnetites at say, 55 per cent. It will then take about 1.8 tons of ore to make one ton of pig iron. Assuming the cost of roasted magnetite at the furnace at \$2.50 per ton, including in this figure 50 cents as royalty to the mine owner, then the cost of ore per ton of pig iron will be \$4.50. The cost of lime per ton of pig iron may be estimated at 50 cents. The cost of labour is higher in British Columbia than in other provinces of the Dominion. Assuming a furnace capacity of 150 tons per 24 hours, and a production of two tons of pig iron per man employed, at \$3.50 per day, the cost of labour will be \$1.75 per ton pig iron. The following is the approximate cost, based on the above figures:—

Ore (magnetite 55 per cent iron) 1.8 tons at \$2.50 per ton..	\$4 50
Coke 1.25 tons at \$6 per ton	7 50
Lime	0 50
Labour at \$3.50 per day	1 75
Steam raising for blowing engine	0 15
Miscellaneous materials, repairs, maintenance, general expenses, and amortization (machinery and buildings) say.	1 60
Total	<hr/> \$16 00

Cost of Pig Iron.

Through the courtesy of the Secretary of the Victoria Board of Trade, the following information has kindly been furnished:—

Approximate Figures of Pig Iron during the past few Years.

Brands.	Price delivered at the works, Victoria.
Redcar 1.	\$22 to \$25 per ton of 2,240 lbs.
Eglington 1.	24 " 28 " " "
Glengarnock 1.	26 " 30 " " "
Summerless 1.	26 " 31 " " "

General Conclusions.

Assuming a blast furnace to be erected in the vicinity of the coal mines, the cost of producing pig iron, according to the estimate given, would be \$16 per gross ton, and it has been shown from figures above that the cost of imported pig iron to consumers ranges from \$22 to \$31 per ton. It would, therefore, appear that an iron industry on the coast of British Columbia should be fairly remunerative, provided that the Province has a sufficient market to support such an industry. This is, however, not the case at present, the import of pig iron during the fiscal year ending March, 1908, being only 2,282 short tons.

With such a limited home market, an iron industry would have to find a market for its surplus product outside the Province. A large and growing market is certainly offered by the western United States; but the manufacturers of that country are protected by a customs duty of \$4 per ton on pig iron. The rapid development of the western states seems to suggest that, an iron industry on the Pacific coast of the United States will soon be established. That such an industry, protected by the high import duty of \$4 per ton on pig iron would be a dangerous competitor with a British Columbia blast furnace plant, in this American market, is apparent. On the other hand, it has often been suggested that the Orient would offer a great market. This is a question of the future, but as conditions are now, it seems impossible that a British Columbia smelting furnace, working with expensive labour and fuel, could compete with other iron producers of the world in this Oriental market.

Though a profitable iron industry does not at present seem probable, there is room for confident anticipation that, with the prospective rapid development of the province, the conditions will be more favourable in the future, and that it will then be practicable to turn to profitable account the iron ore resources on the coast of British Columbia.

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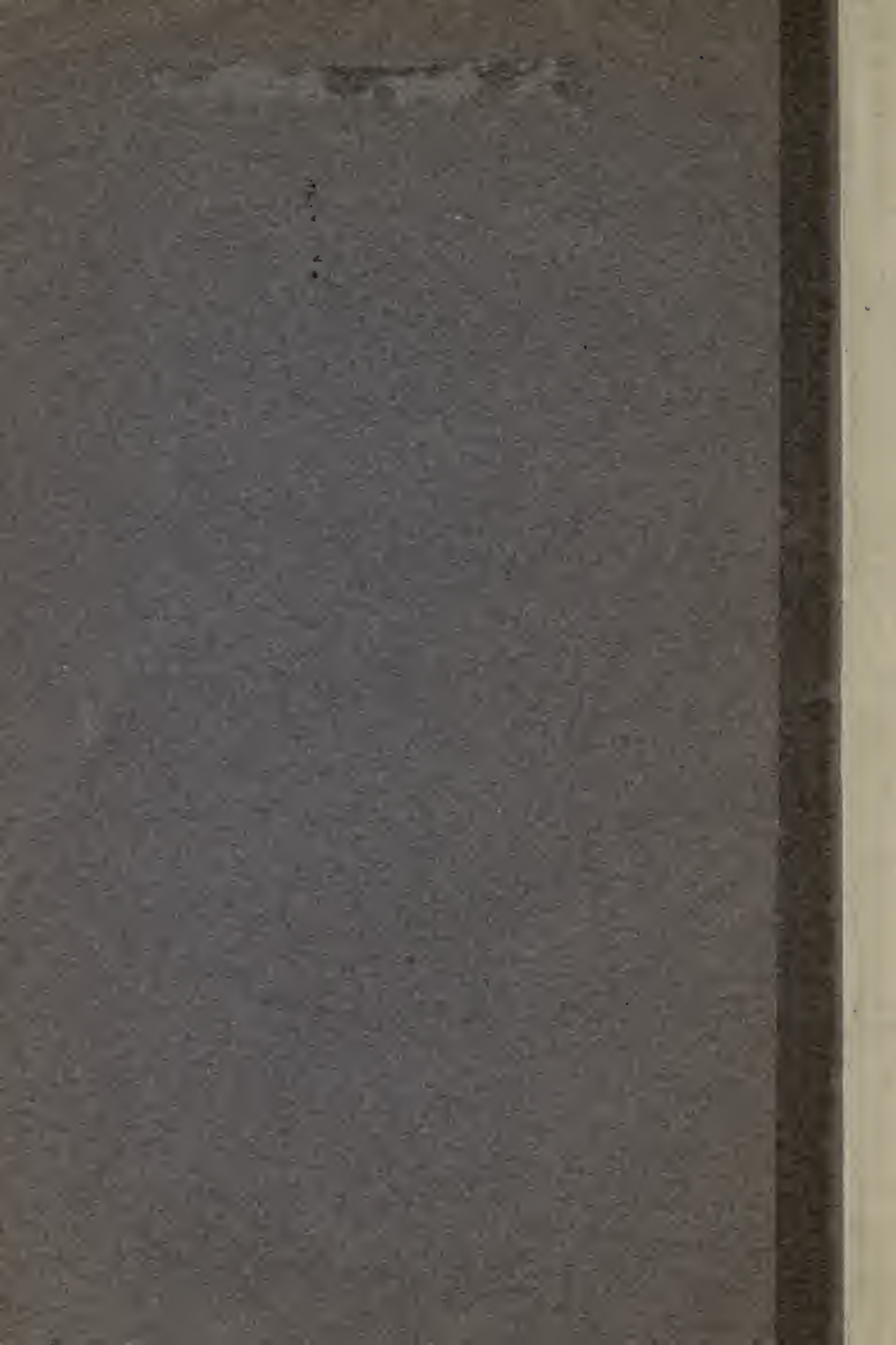
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